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on a journey of exploration into North Africa, — one pregnant result reached being the conclusion that the Sahara was a former sea-basin elevated at a later epoch. Desor distinguished three kinds of deserts: erosion-deserts, sand-deserts, and those of plateaux.

Desor was one of the most active pioneers in prehistorical investigations. He made a costly collection of archæological treasures, and he published, between 1861 and 1881, eleven papers upon the subject, the last being on the fossil man of Nice. When the first International Congress of Anthropologists and Archæologists met at Neuchâtel, in 1866, he was chosen to preside. Desor owned a country-seat on the summit of the Jura, which was the resort, in the summer, of the learned from every country. The names of his famous visitors are inscribed on a tree a century old; among them that of Theodore Parker. Having given the best of his life to science, progress, and freedom, Desor bequeathed to the city of Neuchâtel his rich collections in geology and archæology, and also a large property, which he had inherited from his brother's wife, to preserve and increase them.

JOHN WILLIAM DRAPER.

JOHN WILLIAM DRAPER was born at St. Helen's, near Liverpool, on May 5, 1811. At the age of eleven he was sent to the school of the Wesleyan Methodists, his father being a minister in that denomination. Here and under private tutors he received his elementary education. After the University of London was opened he went there to study chemistry under Dr. Turner. At the age of twenty-two (1832), he was brought by his American relatives to the United States, where he afterwards lived, and where he died on Jan. 4, 1882, in his home at Hastings, on the Hudson. In this country he studied in the University of Pennsylvania, and in 1836 took the degree of Doctor of Medicine. He had already published original papers in the *Journal of the Franklin Institute*, — in 1834, on the Nature of Capillary Attraction, and on the Best Form of Galvanic Batteries; in 1835, on the Magnetic Action of Light. In 1836 the thesis presented for his degree was published by the Faculty of the University. After this, many contributions to science followed in rapid succession, — on chemistry, electricity, heat, light, thermo-electricity, phosphorescence, and kindred subjects. Fifty different papers, published in this country or in Europe, and many of them in several places, are enumerated in the Catalogue of the Royal Society of London which closes with the year 1863.

In 1837 Professor Draper began to publish his researches on the light of the sun, and on the solar spectrum, — a subject to which he often returned down to the year 1873. The discovery of Daguerre turned his attention to photography and photo-chemistry. He anticipated even Daguerre in the art of taking portraits by the action of light. But before the introduction of collodion a long exposure was necessary. As early as 1840 he obtained a photograph of the moon, about one inch in diameter, after an exposure of twenty minutes. In 1842 he announced the paradox of *latent light*, producing images invisible to the eye until revealed by chemical action upon them; whereby a new territory was annexed to the solar spectrum at the violet end, corresponding to the calorific extension at the red end. He was successful in photographing the fixed lines in the solar spectrum, outside even of its visible limits, whether formed by the dispersion of a prism or by the interference of a fine grating. His paper, in which he proved that the decomposition of carbonic acid by the leaves of plants was produced under the influence of the yellow rays rather than of the violet rays of the sun, which appeared originally in the Proceedings of the American Philosophical Society for 1843, was republished in London, Paris, and Berlin.

The results of Professor Draper's experiments on the relation of light to heat were given to the public in 1847. He proved that all solid bodies became incandescent at the same temperature, red hot at 977° Fahrenheit; and that the more refrangible rays were successively added at increasing temperatures, and the original rays became at the same time more intense. Melloni, who may be said to have created the science of radiant heat (so widely did he extend its area), was immediately attracted to these investigations of Dr. Draper, and testified to the ingenuity and success with which they had been conducted. When Kirchhoff, in 1862, published an appendix to his researches on the solar spectrum, in which he gives a mathematical foundation for experimental deductions already known, he said: "Draper has derived from experiment the conclusion that all solid bodies begin to glow at the same temperature. But he has observed in his experiments that certain bodies, as chalk, marble, and fluor-spar, shine at a lower temperature than they should according to this law: he calls this light phosphorescent, and observes that it is distinguished from the glow by its color. But whatever name may be given to the light, it contradicts the law, and a body which shows it cannot satisfy the assumption which is made in proving the law; it cannot remain unchanged, the temperature remaining the same; the phosphorescence is not the

simple influence of heat, it is not exclusively conditioned on temperature, but it is caused by changes in the body: if these changes, be they chemical or of any other kind, cease, then the phosphorescence must also vanish." This quotation is introduced because it has been thought that Kirchhoff did not sufficiently recognize the value and the priority of Draper's work.

Dr. Draper's experiments on the spectra of various flames, proving that the occurrence of lines, bright or dark, was connected with the chemical nature of the substance producing the flame, brought him to the threshold of spectrum analysis, as now understood. His words are prophetic: "For this reason these lines merit a much more critical examination than has yet been given to them, for by their aid we may be able to ascertain points of great interest in other departments of science. Thus, if we are ever able to acquire certain knowledge respecting the physical state of the sun and other stars, it will be by an examination of the light they emit." If he did not himself fulfil the prophecy, Ångström and Stewart also failed, though they had come so near as to know that a gas when luminous emits rays of light of the same refrangibility as those which it has the power to absorb.

Dr. Draper's later papers (1872) on the Distribution of Calorific and Chemical Activities in the Solar Spectrum reveal a mind luminous in thought and fertile in devising experiments. His final statement is that the different rays of the sun are only distinguished by varieties of wave-length or rapidity of undulation. Whatever other differences appear do not belong to the rays, but to the bodies on which they fall, by which their energy is converted into other forms of energy. The excessive heat at and beyond the red end of the spectrum is the work of the prism, which condenses comparatively the red end and scatters the violet end. As the heat of the diffraction-spectrum was insufficient for experiment, he equalized the dispersion by collecting the rays in the focus of a curved mirror. The superiority in the chemical action at the violet end belongs to the bodies submitted to it, and disappears when they are properly chosen.

These are the fruits, not of richly-endowed scientific research, but of the intervals of leisure left by professional duties. In 1836 Mr. Draper was appointed Professor of Chemistry, Natural Philosophy, and Physiology in Hampden Sidney College, Virginia. In 1839 he was made Professor of Chemistry and Natural History in the University of New York. In 1841 he assisted in the establishment of the Medical Department of the University, was Professor of Chemistry in it, and afterwards President. A Treatise on Chemistry, first published

in 1846, reached its tenth edition in 1852; another on Physiology, which appeared in 1856, arrived at its seventh edition in 1875. In 1866 he published a text-book on Anatomy, Physiology, and Hygiene. Some of the Introductory Lectures to his courses have been published; also an address before the New York Academy of Medicine, in 1863, on the "Historical Influence of the Medical Profession." His books and his lectures were vivified by his own fresh explorations into the heart of his profession: the selective action of membranes; endosmosis through thin fibres; the measure of the force of endosmosis; the cause of the coagulation of the blood; the theory of the circulation of the blood; explanation of the flow of sap; respiration of fishes; action of the organic muscle fibres of the lungs; allotropism of living systems; new observations on the action of the skin; function of nerve vessels and their electrical analogies; function of the sympathetic nerve; explanation of certain parts of the auditory apparatus, particularly of the cochlea and the semicircular canals; the theory of vision; the theory of muscular contraction — all these subjects were touched by his laborious experiments.

In 1844 Professor Draper published selections from his scientific papers under the title of "Forces Producing the Organization of Plants." Sir David Brewster, than whom no one of his day was better qualified to speak for the sun, once said to Professor Draper "that the solar spectrum is a world in itself, and that the study of it will never be completed." We have lived to see that it not only is a world in itself, but that it contains the secrets of all other worlds, and is rapidly revealing them to the patient student. In 1875 this Academy awarded the Rumford Medals to Dr. Draper for his "Researches in Radiant Energy." In 1878 he collected his scattered memoirs on this subject, and published them in a single volume of nearly five hundred pages. This publication he regarded as an autobiography of his scientific life. That the reader may not be surprised that it embodies the discoveries distilled from more than forty years of study, he reminds him that days are often required to ascertain a fact that may be stated in a single line. He says: "To a reader imbued with the true spirit of philosophy, even the shortcomings easily detectable in it are not without a charm. From the better horizon he has gained he watches his author, who, like a pioneer, is doubtfully finding his way, here travelling on a track that leads to nothing, then retracing his footsteps; and again, undeterred, making attempts until success crown his exertions." Mr. Draper appreciated the Academy's award as an acceptable return for all his disappointments and all his suc-

cesses, inasmuch as it was "the highest testimonial of approbation that American science has to bestow on those who have devoted themselves to the enlargement of knowledge."

For ten years (1860 – 1870) Dr. Draper relaxed in his experimental work, and soon became a conspicuous author in the republic of letters, addressing a much larger body of readers than are reached by purely scientific works. The moral and intellectual condition of man is so intimately associated with his material organization that physiology, while dealing with the latter, cannot wholly overlook the former. By easy journeys the scientific spirit travels from man as an individual to man in his relation to different countries, races, and epochs. In 1863 Dr. Draper published "A History of the Intellectual Development of Europe." The argument of the book is that man has risen from barbarism to the highest civilization, not by accident, but by a law of growth or evolution, equally applicable to nations and individuals. This book has been translated into many European languages and Arabic, and has passed through various editions. In 1864 Dr. Draper delivered four lectures before the Historical Society of New York, which were afterwards expanded and published in 1865 under the title of "Thoughts on the Future Civil Policy of America." This book has had a large circle of readers, either in the original or in translations. It suggested a more elaborate work, viz. his "History of the American Civil War," which appeared in 1867 – 70, in three volumes. Posterity alone, it is said, can pronounce an impartial verdict on great national issues. Posterity has the advantage of knowing the results, remote as well as immediate, of important events. But it must depend for the facts on the witnesses to those events as they gradually come to light. Dr. Draper said, "More depends on the impartiality of the writer than on the deadening lapse of time." Enjoying the confidence of the Secretary of War, admitted to an inspection of the public documents on both sides, trusted by many who took a conspicuous part in the military and civil crises of the period, Dr. Draper had great advantages for writing a faithful narrative. Posterity must decide whether he has recorded the dispassionate judgments of a cool, scientific observer, or has written as a heated partisan. The last work from the pen of Dr. Draper appeared in 1874, a "History of the Conflict of Religion and Science." There is no conflict between religion and science. If he had called his subject a "History of the Conflict between Theology and Science," it would have been more intelligible, and would have disarmed much of the criticism upon it. This work has had a great circulation, having been translated into

more than seven languages. Dr. Draper has shared with Galileo, Copernicus, Kepler, Locke, and Mill the honor of having his work placed on the Index of books prohibited by the Roman Church.

With such absorbing pursuits, Dr. Draper nevertheless responded to occasional calls made on his literary and scientific attainments. In 1870 he delivered an address before the American Union Academy of Literature, Science, and Art. In 1876 he spoke to the American Chemical Society of New York on "Science in America." In 1877 he addressed the Unitarian Institute at Springfield on evolution. In 1872-3 he is again in the field of scientific research, and only a few months before his death he succeeded in photographing two of the many comets which distinguished the year 1881. Dr. Draper's mind was too large to be shut up within the walls of his laboratory. To him the minutest facts were of value, but only as they furnished the key for interpreting the universal Cosmos of nature and humanity. In clear and graceful language the best that was in his thoughts was shared by the world. There was a continuity in his life-work, plain to himself, if not obvious to the superficial observer. He says: "When I thus look back on the objects that have occupied my attention, I recognize how they have been interconnected, each preparing the way for its successor. Is it not true that for every person the course of life is along the line of least resistance, and that in this the movement of humanity is like the movement of material bodies?"

LEWIS HENRY MORGAN, LL.D.

THE HON. LEWIS H. MORGAN was made a Fellow of the Academy in 1868. His parents were of old New England stock, and of this he often spoke with feelings of satisfaction. His father was descended from James Morgan, who settled near Boston in 1646, and his mother from John Steele, who had a home near Cambridge in 1641. At the time of his birth, Nov. 21, 1818, his parents resided in the village of Aurora, in Cayuga County, N. Y. He had the advantage of an excellent preliminary education, and was graduated at Union College in 1840. He afterwards studied law, and was admitted to the bar. Making his home at Rochester, N. Y., his zeal and honesty soon secured him a large and profitable practice in his profession. In business he was associated with his classmate, Judge George H. Danforth.

In 1855 he became interested in the projected railroad from Marquette to the iron region on the south shore of Lake Superior, and in the development of the iron mines. The management of these enter-